CRITIQUE SUMMARY

Critique No.: CR-CA-2005-0008 **Date of Critique**: 11/03/2005

Critique Leaders: J. Sandberg and R. Karol

Meeting Participants: (met in small groups separately on 11/3, 11/4 and 11/7) T. Nehring, D. Bastedo, A. Zaltsman, N. Laloudakis, S. Farooq, J. Boomer, J. Dowd

Brief Event Description:
On 11/1/05 at about 1000 a worker at Building 929 was cutting wires as part of a Radiofrequency (RF) Power Amplifier repair. Unknown to the worker, the wires were energized with both 120 Vac and DC 170 Vdc . After the wire was found to be energized, we discovered an incomplete review of hazards was made and only the AC energy source was de-energized. When the worker cut one of the wires that was still energized with DC power, a small arc occurred. He stopped work and informed his supervisor. Further investigation showed that a supply breaker's capacitor-trip-device was energized by an Uninterruptible Power Supply. This was the energy source that was not considered before work began. The energy in the capacitor was about 30 Joules, well above the BNL Range A Electrical Hazard limit of 10 Joules. Thus, the DC energy was hazardous. There was no shock or injury to the worker and no equipment damage. After the worker informed his supervisor of the arc, the DC source was de-energized and the splicing was completed. The Collider-Accelerator Department (C-AD) Chief Electrical Engineer and the C-AD ESHQ Division Head were informed of the situation.

The C-AD Department Chair issued an order that every electrical task at C-AD requires a documented hazard analysis before start of work. Low hazard or skill-of-worker tasks will require enough analysis/documentation to ensure that the potential hazards have been understood and compensated for.

An investigation was initiated, led by the C-AD Chief Electrical Engineer, to determine the details of this event and to determine the extent of condition applicable to other situations throughout the C-AD complex.

Reference Materials (e.g., work procedures, written statements, etc.):
Reportable Occurrence Report Number: SC--BHSO-BNL-AGS-2005-0003, Energized Wire Discovered During RF Power Amp Repair

RELEVANT FACTS AND DATA ASSOCIATED WITH THE EVENT
(e.g. event chronology, work activities at variance with governing documentation, etc.)
During the week of 10/17 a worker was given the task of reworking cables from a transformer and circuit breaker that entered Building 929 basement where the AGS RF Cavity Power Amplifiers are located. This work was performed to restore the RF Cavity K power amplifier. Last November a capacitor fire in the K amplifier cabinet caused damage to the amplifier and cables above it (see Reportable Occurrence Report No.: CH-BH-BNL-AGS-2004-0006, Fire Inside Power Supply Cabinet). The cables that were involved in this incident were cut back to where they penetrate the north building wall. The cut back occurred when the cables were fully de-energized and locked and tagged out after that fire. The three cables were from a transformer and circuit breaker located outside the building.

The circuit-breaker high-power output was properly locked out and tagged out during the AGS running period in FY05, and the AGS K RF Cavity was supplied with energy from a spare power amplifier. During the recent maintenance shutdown, the damaged power amplifier was replaced with a spare unit in order to restore it as the K RF Cavity Power Amplifier. Instead of replacing the damaged cables all the way back to the transformer and supply breaker outside the building, a splice box was to be located on the north wall near the roll-up door. The existing cables entering the building would be spliced with new cabling and run from the splice box to the K Cavity Power Amplifier. At the start of work, one cable was cut and a spark occurred. The worker stopped work and informed his supervisor. A tic tracer was used to test the cable and it was found to be energized by an AC source. This cable was thought to have been de-energized all year. The RF Group job supervisor had the C-AD Electrical

CRITIQUE SUMMARY

Group contact the BNL Plant Engineering Line Crew to determine the source of energy and remove it. The Line Crew removed three AC power fuse blocks inside the outdoor circuit breaker and the line was verified to have no AC supply using a tic tracer device. It is noted that a tic tracer is not an acceptable way to verify a zero energy state. Unknown to any of the involved personnel there was still DC energy on one of the cable wires. A tic tracer does not detect the presence of DC energy. The worker was told by the job supervisor that the cable was de-energized and the work was restarted based upon this verbal report. At about 1000 on 11/1, the worker was splicing the wire and noticed another arc. He informed his supervisor who again contacted the C-AD Power Distribution Group. Further investigation showed that the wire had about 166 Vdc which was supplied by the DC trip circuitry for the supply breaker. An uninterruptible power supply (UPS) in the basement of Building 929 maintained a Capacitor Trip Device, located inside the outdoor breaker cabinet charged to the 166 Vdc. At this point the DC energy source was removed and the splicing work was completed. The C-AD Power Distribution Group Leader then informed the C-AD Chief Electrical Engineer and ESHQ Division Head of the problem. Additionally, after hearing of the incident, the C-AD Department Chair issued an order that every electrical task at C-AD requires a documented hazard analysis before start of work.

A preliminary investigation was initiated to determine the significance of this incident and if it was reportable under the ORPs reporting system. When enough information was gathered to determine that the DC source was about 30 Joules, greater than the threshold for a BNL class B electrical hazard (>10 Joules), a reportable occurrence was declared at 1050 on 11/2/05.

ANALYSIS OF RELEVANT FACTS AND DATA:

Probable Causal Factors:

1. Incomplete identification of hazards during work planning. (DOE's ISM Core Function 2, Identify and Analyze Hazards)
2. The workers and work planners made assumptions, not once but twice, and created an inadequate mental picture of the potential hazards involved in a "skill of the worker" job. They assumed the cables were de-energized and did not check the first time, and improperly checked the second time. (Human Performance Error Precursor)
3. Improper Lock Out Tag Out of the system caused by inadequate review of the energy sources. This was a latent error that existed for about a year as the cut cable was hanging near the wall in Building 929. (DOE's ISM Core Function 3, Develop and Implement Hazard Controls)
4. Failure to report the first arc to the ESH coordinator and properly review this unexpected event. (Human Performance Error Precursor)
5. Reliance on "word of mouth" from perceived system experts to workers. (Human Performance Error Precursor)
6. Lack of proper Lock Out Tag Out and required zero energy checks before starting work. If Lock Out Tag Out and zero energy checks were made before the start of the splicing, no safety issues would have occurred. (DOE's ISM Core Function 3, Develop and Implement Hazard Controls)

Recommended Corrective Actions:

1. Improve identification and analysis of hazards for low hazard and skill of the worker jobs.
2. Retrain involved personnel in the implementation of hazard controls for electrical safety.
3. Issue a memo reinforcing that tic tracers can not be used for zero energy checks, which should aid in the implementation of appropriate hazard controls.
4. Label RF Cavity Power Amplifiers to warn of the presence of AC control power and DC trip power in the amplifiers, which should aid in the identification of hazards.
5. Train C-AD work planners, supervisors and workers in pre-ob briefings, walkthroughs and post job feedback using INPO Human Performance concepts to improve the culture of effective communications, teamwork and respect for injury potential during all types of work. This training should reduce the frequency of error precursors.
6. Review C-AD electrical distribution systems for similar conditions where multiple energy sources are present and develop written lock out tag out procedures as required by SBMS for these multi-energy supplied systems. This should aid in implementing ISM Core Functions 2 and 3.

CRITIQUE SUMMARY

7. Retrain all C-AD staff and Experimental User Work Planners on the Work Control System and management expectations for work controls using Integrated Safety Management Core Functions and Guiding Principles.
8. Write a Lesson Learned document so all of BNL can learn from this experience.

Recommended Lessons Learned:

1. Reliance on word of mouth from system experts or reliance on assumptions does not remove the requirements to initiate adequate hazard reviews, LOTO, zero energy checks and the responsibility to ensure one's own safety while performing work.
2. Proper hazard identification of hazards and zero energy checks before starting "skill of the worker" electrical work would have caught the AC and DC energy that was supplied to the wires.

Signature:

__***Signature on File***_____ _____

__***Signature on File***_____ _____

Critique Leaders Date